

CA
1
IA
80
L174



Indian and Northern
Affairs Canada

Affaires indiennes
et du Nord Canada

CA1 IA 80L174



Non-Renewable Resources and Transport

**Background
Report IV**

Earth Sciences Library

Lancaster
Sound
Regional
Study



Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

<https://archive.org/details/31761056890031>

Lancaster Sound Regional Study

Background Report No. IV

NON-RENEWABLE RESOURCES AND TRANSPORT
OF THE LANCASTER SOUND REGION

Non-Renewable Resources

by S.A. Kanik, Exploratory Operations Section,
Department of Indian Affairs and Northern
Development

Shipping

by A. Geddes, Canadian Coast Guard, Transport
Canada

Published under the authority of
the Minister of Indian Affairs
and Northern Development
Ottawa, 1980.
QS-8246-004-EE-A1

Cette publication peut aussi être obtenue en
français

GENERAL INTRODUCTION

This report is one of five background reports prepared as part of the current study of marine and land-use options (Green Paper) for the Lancaster Sound region in the Northwest Territories. These reports are based on existing data, and together represent a body of information on which further discussion, analysis, and planning can be based. Information topics were selected on the basis of their relevancy to a particular resource use, or to provide a regional perspective of combined current or potential resource uses.

These reports and accompanying maps are being made available at this time to foster thorough discussion of the issues by interested organizations, residents of the Lancaster Sound region, and concerned members of the public. Comments arising from the public discussion and any new information will be incorporated into a final report and map set to be published later.

The study of the Lancaster Sound region is being co-ordinated by the Department of Indian Affairs and Northern Development and carried out in co-operation with the Departments of Energy, Mines and Resources, Environment, Fisheries and Oceans, Transport, and the Government of the Northwest Territories.

Copies of other background reports are available by writing to:

Dr. Herman J. Dirschl,
Project Manager,
Lancaster Sound Regional Study,
Department of Indian Affairs and Northern
Development,
Room 631, North Tower,
Les Terrasses de la Chaudière,
OTTAWA, Ontario.
K1A 0H4

or by telephone at (819) 997-0223.

Other Background Reports

Report I: Selected Physical Characteristics

Report II: Selected Biological Characteristics

Report III: Socio-Economic Characteristics
and Conservation Interests

Report V: Jurisdictions and Legislation

Non-Renewable Resources

by S.A. Kanik

SAND AND GRAVELS

Introduction

Nearby sources of gravels, sands, and other construction materials will be necessary for large-scale civil engineering projects which may be undertaken in the Lancaster Sound region.

The northern limit of the Wisconsin Laurentide ice sheet concurs generally with the location of the Northwest Passage. Those islands bordering the Northwest Passage on its south side thus have an abundance of surficial deposits that have resulted from Wisconsin glaciation, in addition to those deposits formed by non-glacial processes. From inspection of Map 1253A, a Glacial Map of Canada, and photomosaic maps, surficial deposits of the Wisconsin Age are seen to be abundant on the islands of Somerset and Prince of Wales. These deposits consist of end moraines, kame moraines, ground moraines, eskers, kames, drumlins, drumlinoid ridges, pitted lacustrine deposits, and hummocky terrain and

deltas at the mouth of most rivers.

Those islands bordering the north side of the Northwest Passage have been largely unaffected by Wisconsin glaciation; the few surficial glacial deposits are of a pre-Wisconsin age.

Raised beaches are prominent on the south side of Cornwallis, Prince of Wales, and Bathurst (east half) islands and on the north side of Somerset Island. Deposits of gravel, sand, silt, and clay are associated with most of these glacial features.

Map No. 4.10 shows in general outline areas where gravel and sand deposits could be expected to occur.

Completeness of Data and Need for Additional Study

Data were acquired from photomosaic and glacial maps. However, detailed on-ground mapping will be required precisely to identify and map the areal distribution and quality of deposits.

Relationship with Other Subject Areas

Mining of superficial deposits should pose no problems to birds, marine life, and mammals. Some sea birds may be disturbed if a large structural deposit site to be mined coincides with a nesting area.

MINERAL DEPOSITS AND POTENTIAL

Introduction

One mine, Nanisivik, is already in production and a second mine on Little Cornwallis Island will be in production in early 1983, following an announcement by the Minister of Indian Affairs and Northern Development in November 1979 (see Appendix A).

The mining industry has a very significant impact on the Lancaster Sound area and its effects on the people, ecology, and marine environment must be considered.

Current Situation of Mining and Mineral Potential

Assessment of the mineral potential of rocks underlying the Northwest passage must essentially be based on (i) an inventory and assessment of known mineralization in similar lithologies on the adjacent islands; (ii) the depth and extent of potential mineral-bearing lithologies

underlying the Northwest Passage; and (iii) an assessment of the feasibility of mining deposits found in (ii) assuming mineralization on a tenor and reserve similar to deposits on the adjacent islands.

This presentation reviews mineral deposits and occurrences on the islands adjoining the Northwest Passage, and gives a brief conclusion on the economic feasibility of mining deep deposits under large bodies of water.

Defined Mineral Deposits

Nanisivik Mines

Lead-zinc mineralization of the Mississippi Valley type occurs in karsted dolomite of the Helikian Society Cliff formation at Strathcona Sound near the northwest end of Baffin Island. Mineralization consists of pyrite, sphalerite, galena, and marcasite enclosed in a large mass of pyrite. This deposit is enclosed in flat-lying rocks and is essentially strata bound. Production started in 1976; in 1978, 128 486 t (metric tonnes) of zinc concentrate and 11 900 t of lead concentrate were produced and shipped from Arctic Bay. Current reserves of 5.3 million tonnes are composed of 1.54 percent zinc, 1.23 percent lead, and 51 g/t silver.

A total of 205 people are employed at the mine.

Arvik Mines (Polaris Deposit)

Lead-zinc mineralization of the Mississippi Valley type occurs in mid-Ordovician Thumb Mountain dolomite on the southwest edge of Little Cornwallis Island. Mineralization is found as massive and disseminated galena and sphalerite in vugs (cavities) and fractures of dolomitic limestone. Reserves equal 22.7 million tonnes and contain 14.1 percent zinc and 4.3 percent lead.

The mine will start production in early 1983 with tentative annual exports of 209 000 t of zinc concentrate and 45 000 t of lead concentrate.

It is anticipated that 250 people will be employed at the mine.

Arvik Mines (Eclipse Deposit)

Lead-zinc mineralization occurs in brecciated dolomite and limestone of the Ordovician Thumb Mountain formation on the eastern lobe of Little Cornwallis Island some 50 km northeast of the Polaris deposit. The West Breccia Zone of the deposit contains 0.9 million tonnes made up of

12.43 percent zinc and 2.18 percent lead. The East Breccia Zone includes 243 000 t containing 3.60 percent zinc, and 238 000 t composed of 3.45 percent zinc and 2.19 percent lead. Development depends on exploitation of the main Polaris deposit.

Baffinland Iron Mines

A strata-form hematitic iron formation occurs in Aphebian metasediments adjacent to Mary River on northern Baffin Island, some 10 km south of Milne Inlet. Five deposits contain reserves of 112 million tonnes of 68.13 percent iron; the potential for additional reserves is considered excellent. The most recent economic assessment (1977) of the deposits indicates that they are not economically viable. If the deposit does go into production, the iron would probably be shipped from Milne Bay.

Mineral Exploration and Potential

Intense exploration has been undertaken for lead-zinc mineralization of the Mississippi Valley type within favourable Helikian and Ordovician carbonate zones of northern Baffin Island and the Cornwallis lead-zinc district.

The Cornwallis lead-zinc district encompasses all Cornwallis and Little Cornwallis islands, Grinnell Peninsula of Devon Island, the east edge of Bathurst Island, Little Truro Island, and other small islands. Exploration in this area has no less than 12 lead-zinc occurrences in addition to the deposits discussed above.

Uranium exploration has been undertaken in north-central Baffin Island and on the west side of Somerset Island over Archean and Proterozoic sediments and metasediments. To date no significant evidence of uranium has been found.

Exploration for copper mineralization has been undertaken in a large belt of Proterozoic volcanics and sediments on the north part of Victoria Island. Several occurrences have been defined.

Ultrabasic and kimberlite intrusions that are diamond-bearing have been defined on Somerset Island. Unfortunately exploration to date indicates that the diamond content is quite low.

Coal occurrences are found on most of the islands adjoining the Northwest Passage, including Prince Patrick, Banks, Melville, Bathurst, Cornwallis, Devon, and Baffin islands. Coal exposures are found in rocks from Upper Devonian to Tertiary in age. Most occurrences

are of bituminous coal found in Lower Cretaceous sediments. Coal deposits near the Salmon River and west of Pond Inlet on north Baffin Island were mined intermittently for heating purposes from 1925 to 1960. These deposits may be of increasing importance to the people of northern Baffin Island due to the increase in the cost of oil products.

Conclusions

The most significant types of economic mineralization known to date in the Arctic are massive lead-zinc Mississippi Valley type deposits that are contained in Helikian and Ordovician carbonates on Baffin and Little Cornwallis islands respectively. The mineral potential of rocks underlying the Northwest Passage may therefore be equal to the equivalent rocks exposed on the adjacent islands. The potential for lead-zinc mineralization in a form similar to that found in the Nanisivik and Arvik mines is, of course, present. Seismic data are not definitive in establishing that Ordovician carbonates hosting the Thumb Mountain or the Helikian Society Cliff formations are present under Barrow Strait and Lancaster Sound. Even if the carbonates are present, the extreme depths

Table 1
Exploration Activity

<u>Year</u>	<u>Company</u>	<u>Surface Parties</u>	<u>Man-Months</u>	<u>Area</u>
1979	Data not available at this time			
1978	Nanisivik	1	4-8	Nanisivik
	Shell Canada	1	4-8	Harker Creek
	Diapros Canada	1 (?)	3	Pond Inlet
	Canadian Superior	1	6	Cornwallis Is.
	Tregg Woolett	1 (?)	3	Prince of Wales Is.
	Tregg Woolett	1 (?)	3	Somerset Is.
1977	Uranerz	2	20	Borden Peninsula
	Shell Canada	1	4-8	Harker Creek
	Noranda	1 (?)	3	Northern Baffin Is.
	Canadian Superior	1 (?)	3	Cornwallis Is.
1976	Canadian Superior	1 (?)	3	Cornwallis Is.
	Noranda	1 (?)	3	Northern Baffin Is.

Summary

<u>Year</u>	<u>Surface Parties</u>	<u>Man-Months</u>
1979	Data not available at this time	
1978	6	20
1977	5	30
1976	2	4

Mineral exploration forecasts cannot be made.

due to overlying water and covering sediments make mining not only economically unfeasible but physically impossible. (Depths in Lancaster Sound to Paleozoic tops are from 1.75 to 6.5 km, depths to Helikian tops are from 2.25 to 8.3 km.

The possibility for economic extraction of deep mineral deposits below the Northwest Passage must be considered very low. The only possibility might be extraction from the seaward extension of a deposit defined on land. At Arvik, lead-zinc mineralization found on the surface is known to project under McDougall Sound. However, that particular mineralization will probably not be mined because of the extremely porous nature of the overlying dolomite hanging wall that would probably cause extensive intrusion and flooding from sea water.

Sea-bed occurrences of nickel, manganese, and other minerals are not expected to be present in the Lancaster Sound area due to recent glaciation which distributed a thick mantle of glacial deposits.

Completeness of Data and Need for Additional Study

The current knowledge of the Lancaster Sound area compared to that of the more developed areas of

Canada is cursory, but it is adequate to study its current and future impact on other subject areas. Information deficiencies are of scale, not quality.

Studies will be continued both by government agencies and industry on a need-to-know basis. Since no smelting or metallurgical processing will be undertaken at either mine site, impacts on the environment will be superficial.

Relationship with Other Subject Areas

We do not envisage any problems with or threats to other aspects of the northern environment as a result of the two mines now in production.

OIL AND GAS RESOURCES AND POTENTIAL

Introduction

The government's National Energy Strategy for Self-Reliance announced in the spring of 1976 sets forth a specific target "to double, at a minimum, exploration and development activity in the frontier region of Canada over the next three years, under acceptable social and environmental conditions."

Early drilling in Lancaster Sound is important to the government for energy-resource assessment and to provide lead time for rational

planning for future energy supplies, particularly for Eastern Canada. The discovery of commercial gas reserves in Baffin Bay-Lancaster Sound could affect planning for proposed projects for transporting liquid natural gas from the Arctic Islands.

Oil and gas exploration started in the Lancaster Sound region in the late 1950s. By 1964 a well was drilled at Resolute, and large-scale marine seismic programs were undertaken in Lancaster Sound and Baffin Bay in the late 1960s and 1970s. Additionally, wells were drilled on Somerset, Devon, and Prince of Wales islands.

Drill sites have been identified in Lancaster Sound; oil companies hope to receive DIAND approval to drill them as soon as possible. Certain hazards are associated with drilling and production of hydrocarbons and it is these hazards that may affect the bird and marine life in Lancaster Sound.

Current Situation

Oil and gas permits have been awarded for areas in the Lancaster Sound region; these areas have been explored by extensive seismic surveys and subsequently limited to prime prospective areas.

These prime prospective areas, retained under oil and gas permits but still undrilled, now require drilling to evaluate defined prospective geological structures. Further such activity is also required to maintain permits in good standing. The regions with significant prospects include the Arctic Islands, Baffin Bay, and the Eastern Arctic including Lancaster Sound.

Permits for areas in the Northwest Passage, comprising M'Clure Strait, Viscount Melville Sound, Barrow Strait, and Lancaster Sound were predominantly held by Magnorth Petroleum Limited, a company formed in 1970 of a syndicate of 13 companies, including BP Exploration Canada Ltd., CDC Oil and Gas Ltd., Brascan Resources Ltd., and Home Oil Company Ltd. Permits for lands held by Magnorth were originally issued in 1968 to 1970 for an initial period of six years plus six annual renewals (12 years). Permits were granted for some five to seven million hectares in the Northwest Passage and a small hectarage in the Arctic Islands. From 1970 to 1973, Magnorth conducted 17 169 km of marine seismic work in the Northwest Passage at an estimated cost of \$9.6 million.

Magnorth negotiated an exploration agreement with Northern Natural's wholly owned Canadian

subsidiary, Norlands Petroleum Ltd. From 1973 to 1976, Norlands conducted seismic exploration on 11 209 km at a cost of \$4.0 million and spent an additional \$2.0 million on work supporting a proposed drilling program. Currently Magnorth/Norland holdings total 0.93 million hectares in areas on which \$3.1 million will be spent for work required before the expiry of permits in 1982.

In 1978, Magnorth/Norlands negotiated a further "farm-out" agreement with Petro-Canada Exploration Ltd. which allowed Petro-Canada to drill one well and continued options for two additional exploratory tests.

North Baffin Bay Sector

Current holdings in the North Baffin Bay Sector total 2.2 million hectares held mainly by Petro-Canada and Shell. Past expenditures total \$1.1 million; work required before the expiry of permits will cost \$10.5 million. Most of the permits were issued in 1971 with an expiry date of 1983. The preliminary seismic work during the initial term of the permit was performed by ARCO and Baffin Bay Petroleums. Petro-Canada acquired the latter company in 1977 along with an option

to do seismic exploration and drill wells on Shell lands.

Gas and Oil Assessment

The Lancaster Sound-Northern Baffin Bay region contains some 50 geological structures ranging from 810 to over 40 470 hectares in size with sedimentary thicknesses up to 4 100 m. The ultimate potential of recoverable gas is 1.4 to 1.7 billion cubic metres or about one-third of Canada's currently estimated gas inventory. The oil potential is unknown but reported seeps in Scott Inlet suggest that the basin may also be oil prone.

The Dundas structure, an example of a geological structure in the Lancaster Sound-northern Baffin Bay region, is located in the Lancaster Sound sector and covers more than 25 000 hectares. It could contain 140 200 million cubic metres of gas depending on the thickness and number of reservoirs. Early drilling to evaluate this structure and other prospects in the Lancaster Sound-northern Baffin Bay region is critical to the assessment of Canada's resource potential and delineation of Canada's energy supplies for the future.

Comparative Potential Oil and Gas Resources

The Geological Survey of Canada in 1976 estimated the potential of recoverable oil and gas from conventional sources in Canada at 50 percent probability to total 6 billion cubic metres of oil equivalent. The potential oil and gas resources in Canadian frontier basins north of the 60th parallel of latitude, more than half of which are in the northern offshore area, amount to 50 percent of those in the whole country.

On the basis of an updated review of the Lancaster Sound area, the estimates of potential oil and gas resources have been revised modestly upwards; it is estimated that this area contains 8 percent of Canada's total potential petroleum resources.

The most potentially productive areas of Baffin Bay and Slope encompass three submerged deltas: Lancaster, Home Bay, and Cumberland Basin. These basin depocentres received large influxes of sediments from the Canadian Shield. The major geological structures are horsts (relatively raised blocks) and grabens (relatively lowered blocks) formed by normal faulting during the separation of Labrador and Baffin Island from Greenland. The horsts, in particular, form potential traps of oil and gas,

both in their Mesozoic and earlier reservoirs created by the faulting, as well as in the Tertiary sediments which drape over the underlying structures.

Physical Environment of Baffin Bay and Lancaster Sound: State of Drilling and Development Technology

Five primary environmental factors are significant to drilling offshore Baffin Island: bathymetry, currents, waves, icebergs, and sea ice.

Bathymetry

Oil and gas permits have been issued for work in water of depths up to about 1 850 m. Imperial and Aquitaine have drilled in water of about 1 000 m deep in the Cumberland and Home Bay areas respectively.

The deepest drilling so far was carried out by Texaco in the summer of 1979. This was in 1 486 m of water off the Labrador coast at the Blue H-28 well.

The capability to drill in deep water is advancing rapidly. No new problems are anticipated in deep-water drilling other than the possibility of lost circulation of drilling

Table 2

Summary of Oil and Natural Gas Resources of Canada, 1975*
 (Remaining reserves, discovered resources, and undiscovered potential)

	Likelihood of Existence					
	High 90% Probability		50/50 chance 50% Probability		Low 10% Probability	
	Oil Resources					
	(billions of barrels)					
	(m ³ in brackets) (10 ⁹ m ³)					
Region						
Atlantic Shelf South	1.20	(0.19)	1.90	(0.30)	3.00	(0.48)
Labrador-East Newfoundland Shelf	1.70	(0.27)	2.60	(0.41)	4.50	(0.72)
Northern Stable Platform Basins	0.01	(0.0016)	0.60	(0.095)	3.20	(0.51)
St. Lawrence Lowlands	0.04	(0.0064)	0.09	(0.014)	0.20	(0.032)
Western Canada	10.90	(1.7)	11.70	(1.9)	13.50	(2.1)
Mainland Territories	0.30	(0.05)	0.50	(0.08)	1.00	(0.16)
Mackenzie Delta-Beaufort Sea	4.30	(0.68)	6.90	(1.1)	12.00	(1.9)
Sverdrup Basin	1.10	(0.17)	2.00	(0.32)	4.00	(0.64)
Arctic Fold Belts	0.50	(0.08)	1.80	(0.29)	4.30	(0.68)
Total Canada (accessible regions)	25	(4.0)	30	(4.8)	43	(6.8)

Table 2 (continued)

Region	Gas Resources					
	(trillions of cubic feet)					
	(m ³ in brackets)					
	(10 ¹² m ³)					
Atlantic Shelf South	8.60	(0.24)	13.20	(0.37)	20.00	(0.56)
Labrador-East Newfoundland Shelf	18.00	(0.50)	26.70	(0.75)	45.00	(1.3)
Northern Stable Platform Basins	0.40	(0.011)	2.30	(0.064)	12.00	(3.4)
St. Lawrence Lowlands	0.70	(0.02)	1.40	(0.039)	3.20	(0.09)
Western Canada	89.00	(2.5)	97.00	(2.7)	107.00	(3.0)
Mainland Territories	6.00	(0.17)	9.70	(0.27)	20.00	(0.56)
Mackenzie Delta-Beaufort Sea	39.00	(1.1)	60.00	(1.7)	99.00	(2.8)
Sverdrup Basin	21.00	(0.59)	40.00	(1.1)	80.00	(2.2)
Arctic Fold Belts	2.90	(0.081)	11.00	(0.31)	26.00	(0.73)
Total Canada (accessible regions)	229		277		378	

Note: These columns do not total arithmetically to Canada totals because individual curves must be summed.

* Prepared by the Geological Survey of Canada.

fluids during top-hole drilling because of reduced fracture gradients caused by density differences between sea water and soft ocean floor sediments. Casing program specifications and well control procedures are specially designed to cope with changes in overburden density.

Currents

The properties of the Labrador Current and Lancaster Sound are significant factors in the design criteria of sub-sea operational systems and oil-spill contingency plans are in progress. Some additional data are needed in this field for optimum design of marine risers and connections in deep water.

Waves

Sea conditions affect the time losses due to weather of floating rigs. The average wave height in Davis Strait, east of Revolution Island, is 0.6 m which is less than in most off-shore areas to the south. Heavy seas in the fall, however, limit any operations for drill ships in Baffin Bay-Davis Strait.

Icebergs and Ice

Eastcan's experiences off Labrador have shown

that about one and a half days a season were lost due to icebergs over the period 1973 to 1975. The ability to tow icebergs away from the drill site and the rapid release capability of dynamically positioned drilling vessels (such as ships) to avoid icebergs will be especially important in more northerly waters where the number and size of icebergs increase.

Drilling Technology

Present-day conventional offshore drilling is to depths of about 2 000 m. For deeper-water drilling, it is the cost of equipment and operations rather than technical factors per se that limit the depth of water. Wells are being drilled in 600-1 000 m of water while deep-sea drilling is being conducted for scientific purposes in abyssal depth greater than 9 000 m.

Deep-Water Drilling Equipment

It is not feasible to use a moored drill platform in water depths greater than 80-250 m; rather, some type of dynamically positioned vessel, usually a ship, is used. Where climatic conditions are severe, self-positioning semi-submersibles are increasingly used.

Secondly, where the wellhead is below diver depth and requires a long transmission line, it has been necessary to develop electrohydraulic well control systems. These function in any water depth and allow the wellhead to be operated from the drilling platform.

Thirdly, there is the marine riser, consisting of a flexible connection between the vessel and the wellhead, and used to circulate the drilling mud. With greater depths, the weight of the riser and its response to currents increase, requiring the addition of buoyancy systems to the riser. Very recently, attempts to reduce current effects (drag) have been made by streamlining the riser.

Lastly, because of lack of light and poor visibility and the wellhead being beyond diver depths, access to the wellhead from the surface to facilitate riser reconnections requires special equipment such as acoustic homing devices and conical re-entry configuration wellheads.

Under severe climatic conditions, such as offshore Baffin Island and Lancaster Sound, dynamically positioned vessels permit safer operations than moored rigs. The vessels allow more rapid release of the riser and movement from the drilling location than is possible with

anchored rigs.

Shipping Regulations

The Arctic Shipping Pollution Regulations (1972) cover the construction standards, hull design, and machinery requirements of arctic ships, and the navigation season allowed in arctic waters, by zone for ships carrying more than 16 000 cubic feet of oil. The cabinet decision approving these conditions took the form of an Approval-in-Principle followed by certification of requirements under the Arctic Shipping Pollution Regulations.

Regulations are extended to drill ships and work boats used in drilling systems operating in Canadian arctic waters. Definition of the zones is under the Shipping Safety Control Zones Order (1972); Baffin Bay-Davis Strait falls into zones 3, 6, 9, 10, 13, and 15. In relation to oil and gas permits, the Cumberland Basin is in zone 15, Home Bay is in zone 9, and Lancaster is in zone 13. Accordingly, adequately constructed and equipped drill ships and work boats would be permitted an operational season of up to four months in the Baffin Bay-Davis Strait area.

The practicality of drilling operations in southern Baffin Bay-Davis Strait (Cumberland)

Basin) has been demonstrated by the drilling in offshore Greenland and Labrador. In southern areas, drill ships such as the Pelican and the Petrel were used. The Sedco 709 and newer classes of vessel also have the necessary requirements to drill in these areas. For northern Baffin Bay, in addition to ice strengthening, some further adaption of the technology for marine riser systems and drilling may be required.

Production Technology

State-of-the-art technology for production in deep water is represented by the production systems already established in the development of oil and gas fields in the northern sector of the North Sea. One such system, the Beryl A, is operating at a depth of almost 150 m of water; it has drilling, storage, and production facilities incorporated into a concrete structure sitting on the sea bottom with most of the equipment above water. Stability during storms is dependent on its own weight.

For production systems with wellheads at depths of 450-600 m, extending these gravity structures from the bottom to the surface of the sea is very costly. Accordingly, current development aims at designs in which the

production equipment is incorporated in a structure on the sea floor. Flow of oil and gas from the wellhead would be through a production riser, vertical or articulated, to a surface buoy. A prototype of a three-well system is in place in the Gulf of Mexico.

Additional engineering will be required to further the design of such prototype systems for specific application under northern conditions of pack ice or icebergs. Panarctic Oils completed the construction of gathering and production facilities in the Canadian Arctic during the winter of 1978-1979. A 10- to 15- year time frame will probably be required to resolve the range of oil and gas pool development problems in the deep offshore areas under arctic environmental conditions.

Conclusions

It is concluded that federal legislative and administrative controls implemented by professionally qualified experts from departmental staffs (principally of the departments of Indian Affairs and Northern Development, Transport, and Environment) are adequate to ensure reasonable and effective safeguards and contingency plans for the protection of Canada's arctic environment.

Although the inherent risks of accidental pollution of the arctic marine environment cannot be reduced to zero, the risks are considered to be low and reasonable compared to the probable national and regional economic and social benefits that could accrue.

Completeness of Data and Need for Additional Study

Seismic data quality is excellent and adequate to evaluate the structural attitudes of the sedimentary basins in the Lancaster Sound region. It is from these data that industry has outlined drillable anomalies and decided it wants to proceed to the drilling stage, which requires drilling approvals from the government.

The only problem encountered in data acquisition was the presence of ice floes which delayed seismic programs during the operational periods.

No additional seismic studies are required prior to the drilling of specific sites. In the event of oil or gas discoveries, additional seismic studies will be undertaken, together with engineering studies to design sub-sea production facilities and pipeline routes.

Relationship with Other Subjects

Drilling, well production, and seismic and transportation operations should pose no threats to other elements of the environment providing that oil spills do not occur. Production of oil and gas is a major industry in the Mississippi, Niger, and Nile deltas and is compatible with other marine industries and habitats. In the event of oil spills certain environmental damage will affect marine life, and it is this potential effect that must be identified and quantified.

APPENDIX A

THE DEVELOPMENT OF ARVIK MINE IN THE N.W.T.

OTTAWA (November 6, 1979 --- Cominco's decision to develop the world's northernmost operating mine was hailed today by Northern Development Minister Jake Epp as symbolic of the government's determination to foster northern resource development.

The lead-zinc mine site (75°30'N 97°W) is situated on Little Cornwallis Island in the Northwest Territories 3 800 km by air from Montreal.

Mr. Epp said the mine will advance both northern mining and Canadian shipping technology, as well as contribute to Canadian sovereignty as the country's northernmost privately operated year-round economic activity. Contributions to Canada's balance of payments alone will be \$60 million annually.

The Polaris mine will employ about 250 people and have an annual payroll of about \$4.5 million. The present value of the net benefits of the project (wages, corporate income taxes, royalties) over 20 years could amount to about \$80 million, of which \$20 million would remain in the N.W.T.

It is not expected that the project will

have a major socio-economic impact in the area because of its remoteness from any northern settlements. However, the Minister will ensure that benefits to northern residents are maximized. To this end, the company is required to consult with northern communities and reach agreement regarding their interest and participation in the project.

Although agreement has been reached to enable the company to proceed with its plans for development, the normal regulatory processes provided for by the Northern Inland Waters Act, the Territorial Lands Act and the Arctic Waters Pollution Prevention Act will apply to the development plans of the company when they have been completed.

For the first time in Canada's history, the mining project would use Canadian shipping despite a substantial cost penalty as a concession to government policy, with Cominco agreeing to use the M.V. Arctic for half of the mine's production. The M.V. Arctic is a Canadian built, -owned and -operated ice-strengthened bulk carrier financially guaranteed by the federal government and currently operating at a \$5 million deficit. If the mine is successful, the area's lead-zinc mineral potential could

support several other mines.

The mineralization on Little Cornwallis Island was discovered in 1960. It holds potential reserves of about 23 million metric tonnes of high-grade ore grading 4.3 percent lead and 14.1 percent zinc. In 1971 Arvik Mines Limited, owned 75 percent by Cominco Ltd. and 25 percent by Bankeno, was formed to develop the deposit.

BACKGROUNDER

1. Export Permit for Concentrate

Pursuant to Section 76.1 of the Canada Mining Regulations, the export of the mine production will be authorized to the amount of 1.1 million short tons of zinc and lead metal contained in the ore or concentrates, or for a period of eight years, whichever event occurs first.

2. Further Processing

Cominco has indicated that it would undertake a smelter feasibility study during the fifth year after the beginning of production.

3. Canadian Content

Arvik Mines Ltd. has indicated that about 92 percent of their capital expenditure will be in Canada. Only where no suitable or competitive Canadian equipment is available will purchases be made abroad.

4. Shipping

Cominco would, as already agreed, ship one-half the mine's production with the Canarctic Consortium on the basis of normal

commercial guarantees, and would include the use of M.V. Arctic at full operating cost.

With regard to the shipment of the second 50 percent of the concentrates, preference should be given by Cominco to Canadian flag ships if available and competitive. If competitive bids cannot be obtained for the use of Canadian flag ships, Cominco will be allowed to contract with foreign shippers for the second half of the production for the period of the export licence, namely eight years.

The government will explore further with Cominco alternative methods to strengthen, to the extent possible, the preference Cominco is prepared to give to the use of Canadian ships after 1985.

5. Socio-Economic Factors

The company has already held some discussions with northern communities in the area regarding the employment of native people. Now that the company has announced its decision to proceed with the project, those consultations will intensify. The company will be required to develop recruitment, training and work rotation plans which

reflect the wishes and perception of northern native people. Given such plans, the level of native employment should tend to reflect the available labour force supply.

6. Environmental Considerations

The project has already been referred to the Environmental Assessment and Review Process (EARP) which reports to the Minister of the Environment. After a review by the Federal Environmental Assessment and Review Office (FEARO) it was determined that the potential environmental impacts were not sufficiently great to warrant the triggering of a full assessment and review process.

The normal regulatory process will be used to design the proper environmental terms and conditions. The main component of this process will be the review by the N.W.T. Water Board when the company applies for a water licence. Further, the company will require a land lease, and through the provisions of the Territorial Lands Act, appropriate terms and conditions may be applied when that lease is issued.

Shipping

by A. Geddes

INTRODUCTION

Shipping plays an unseen but vital role in the economic life of most nations. Shipping is, however, only one part of a complex integrated organization that has national and international components. This organization includes financial, mercantile, communications, and marine transportation elements regulated to some extent by government. Economic progress is a continuing objective of commerce, and energy, in its various forms, and selected minerals are essential to progress. Because primary ores and energy sources are distributed unevenly throughout this country and the world, it is often necessary to transport them by ship from remote regions to industrial centres. In addition, remote coastal communities are often supplied with goods and refined products by ships because there are no roads to connect them with their sources of supply.

A number of objectives and policies pertaining to the Canadian Arctic are relevant to

arctic shipping policy.* Federal objectives for Northern Canada include the encouragement of viable economic development so as to realize the North's potential contributions to the national economy and to the material well-being of Canadians. These objectives also point to the maintenance of Canadian sovereignty and security, the protection of the environment, and the social and economic developments in the North. Achieving these objectives will depend, in large part, on shipping because of the absence of highways and the amount of materials to be moved. Figure 1 shows that Lancaster Sound is important to shipping as it is the eastern gateway to the Northwest Passage, the communities near the sound, and the sites of existing or planned mining enterprises.

REGULATIONS AND SUPPORT OF SHIPPING

At present, restrictions on Canadian arctic shipping apply only to the technical characteristics of ships and the particular calendar

*Transport Canada Publication 1676. A Shipping Policy for Canada, 1979.

periods when specified classes of ships are authorized to navigate geographically defined shipping control zones. Shippers are free to select ships of their choice provided the ships comply with the provisions laid down in the Arctic Shipping Pollution Prevention Regulations and the Arctic Waters Pollution Prevention Regulations.

The former relate to technical details of the ship, including cross references to other regulations, and the latter relate to definitions of waste, limits of liability, and evidence of financial responsibility for shipowners. Figures 2 and 3 correlate the explicit calendar periods when 14 specified classes of ships are permitted to navigate each of the 16 arctic shipping control zones. Figure 4 summarizes the periods the 14 specified classes of ships are permitted to navigate Lancaster Sound and vicinity (see Zone No. 13). The relationship between permitted navigation periods, daylight and darkness, and ice cover should be noted. For example, the MV Arctic, rated as an arctic class 2 ship by the Canadian Coast Guard, is permitted to navigate Zone No. 13 (Lancaster Sound and vicinity) from June 25 to November 15. The ship's operational ability to arrive alongside,

or depart from, the Nanisivik terminal during early or late portions of this period is, of course, subject to existing ice-cover and the thickness of ice separating the ship from the Nanisivik terminal.

The Arctic Canada Traffic System (NORDREG CANADA) is a voluntary marine traffic system operated by the Coast Guard. The boundary of this system is depicted on Figure 2. Masters of participating ships obtain a traffic clearance after transmitting by radio prescribed particulars to the Traffic Centre at Frobisher Bay, NWT. Thereafter, the movements of participating ships are monitored by Coast Guard personnel in the Traffic Centre for the period the ships are operating within the NORDREG CANADA boundary. Non-participation in this voluntary system is rare. Traffic Centre personnel provide ship masters with advice on recommended ship routes, aids to navigation, and Coast Guard icebreaker support when available and considered necessary. The safe navigation of shipping, however, remains the unequivocal responsibility of individual ship masters. The Traffic Centre operates from early July until the last ship clears the NORDREG CANADA boundary, usually in October.

The Canadian Coast Guard also operates a

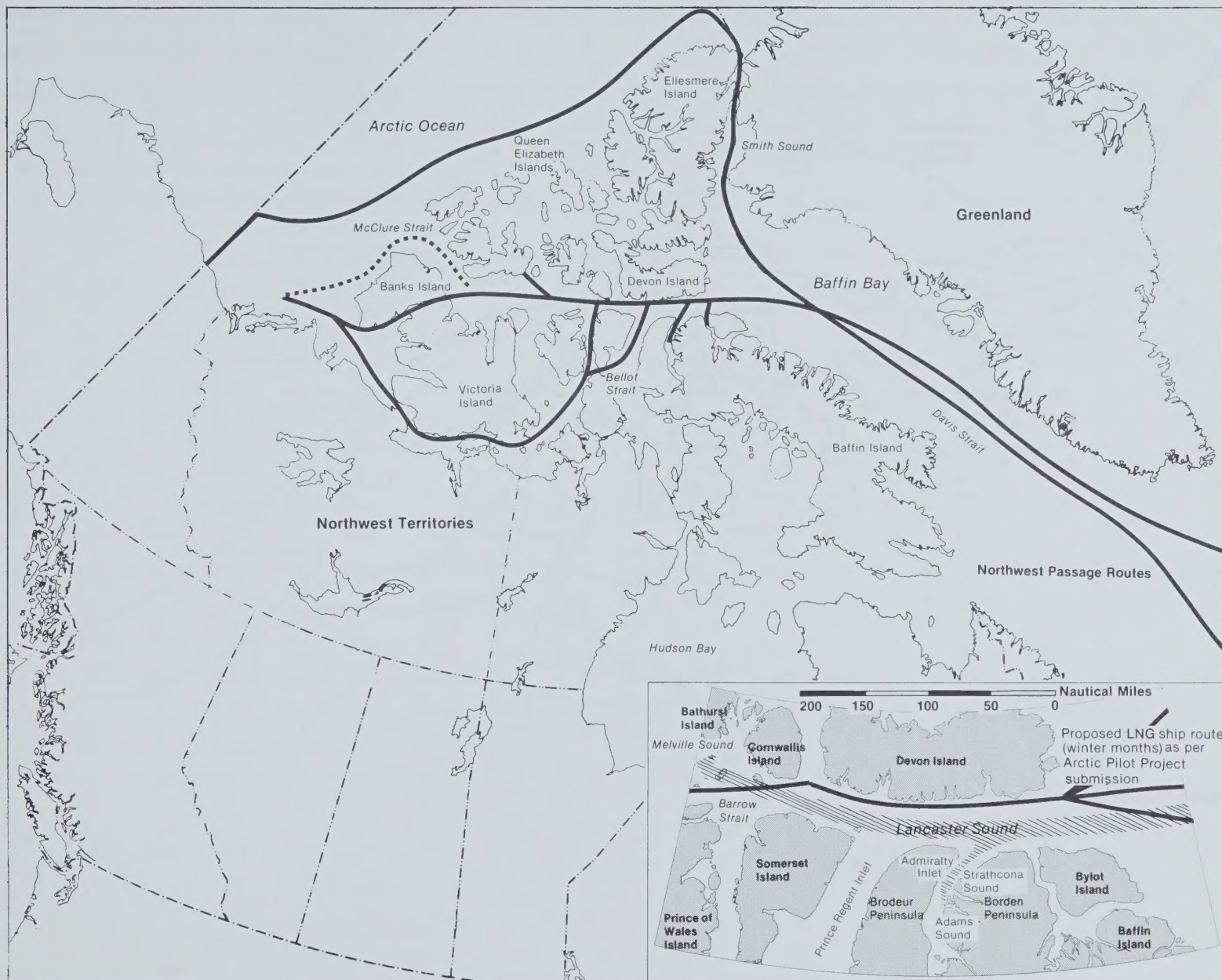


Figure 1 Northwest Passage Routes

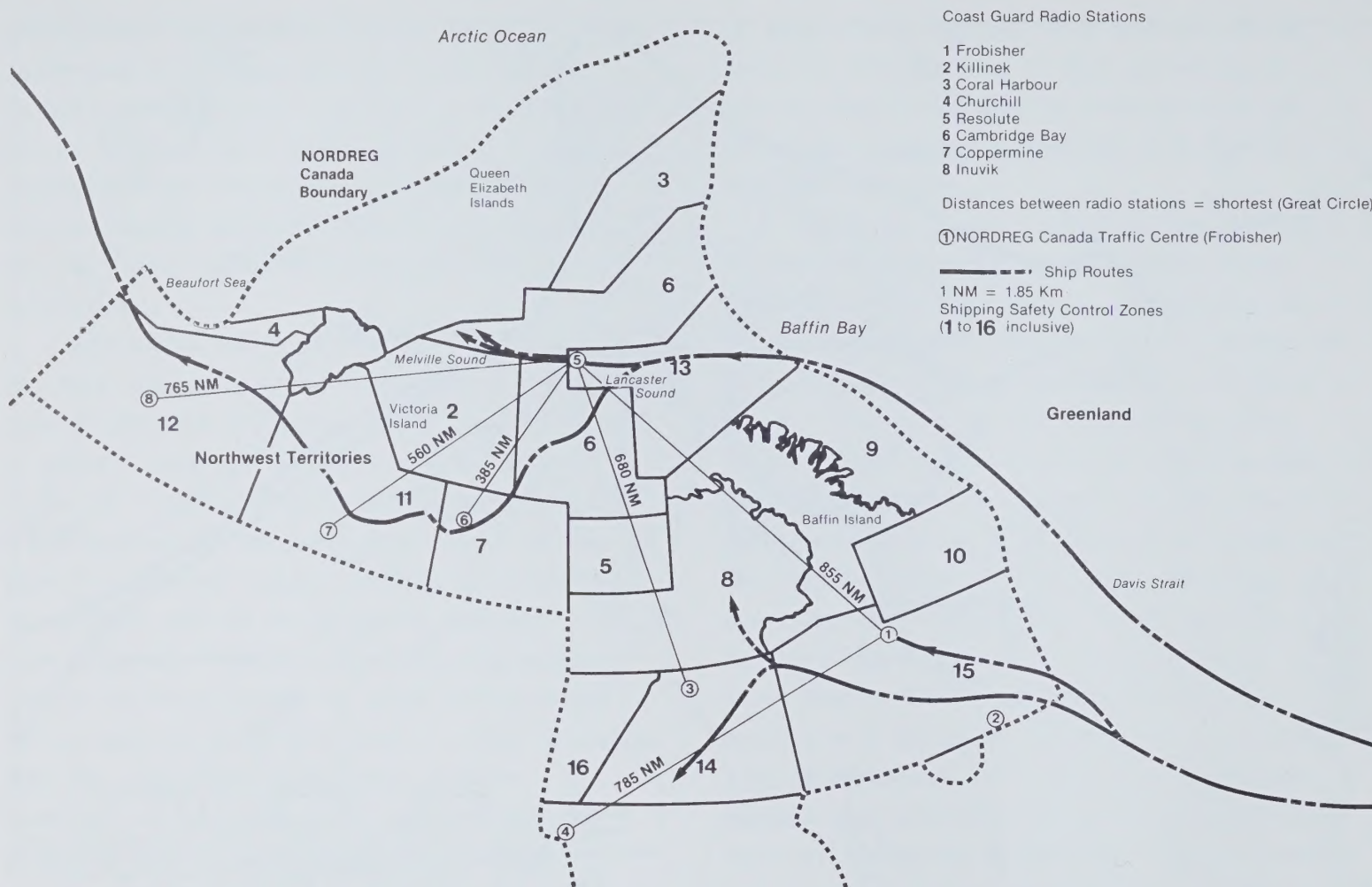
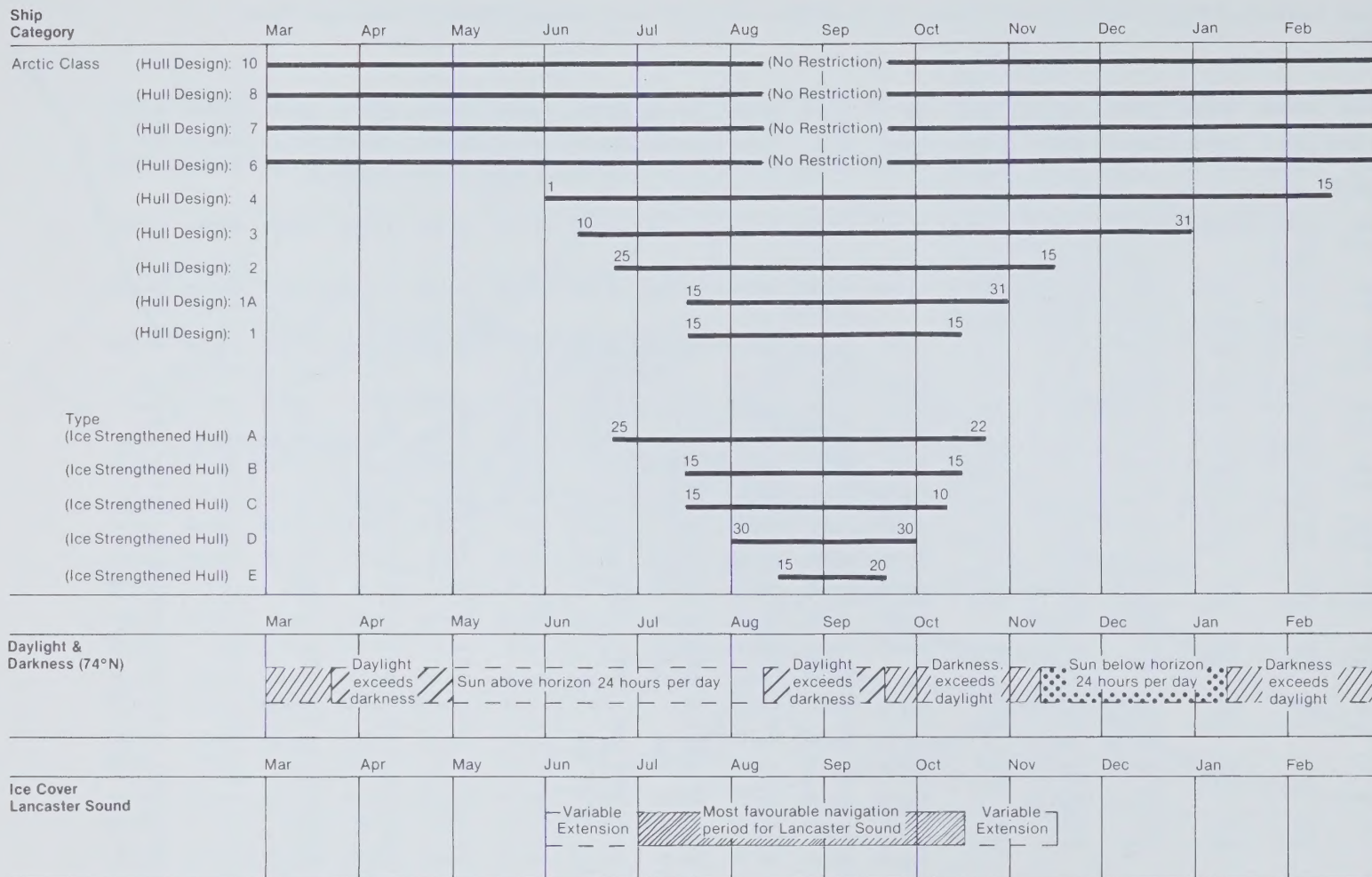


Figure 2 Coast Guard Radio Stations

Figure 3 Authorized Periods of Navigation for Zones 1 to 16 by Ships Carrying 453 Cubic Metres (100,000 Imp. Gallons) of Oil or More

Source: Arctic Shipping Pollution Prevention Regulations

Column I Category	Column II Zone 1	Column III Zone 2	Column IV Zone 3	Column V Zone 4	Column VI Zone 5	Column VII Zone 6	Column VIII Zone 7	Column IX Zone 8	Column X Zone 9	Column XI Zone 10	Column XII Zone 11	Column XIII Zone 12	Column XIV Zone 13	Column XV Zone 14	Column XVI Zone 15	Column XVII Zone 16
Arctic Class 10 1.	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
Arctic Class 8 2.	Jul 1 to Oct 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
Arctic Class 7 3.	Aug 1 to Sept 30	Aug 1 to Nov 30	Jul 1 to Dec 31	Jul 1 to Dec 15	Jul 1 to Dec 15	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year	All Year
Arctic Class 6 4.	Aug 15 to Sept 15	Aug 1 to Oct 31	Jul 15 to Nov 30	Jul 15 to Nov 30	Aug 1 to Oct 15	Jul 15 to Feb 28	Jul 1 to Mar 31	Jul 1 to Mar 31	All Year	All Year	Jul 1 to Mar 31	All Year	All Year	All Year	All Year	All Year
Arctic Class 4 5.	Aug 15 to Sept 15	Aug 15 to Oct 15	Jul 15 to Oct 31	Jul 15 to Nov 15	Aug 15 to Sept 30	Jul 20 to Dec 31	Jul 15 to Jan 15	Jul 15 to Jan 15	Jul 10 to Mar 31	Jul 10 to Feb 28	Jul 5 to Jan 15	June 1 to Jan 31	June 1 to Feb 15	June 15 to Feb 15	June 15 to Mar 15	June 1 to Feb 15
Arctic Class 3 6.	Aug 20 to Sept 15	Aug 20 to Sept 30	Jul 25 to Oct 15	Jul 20 to Nov 5	Aug 20 to Sept 25	Aug 1 to Nov 30	Jul 20 to Dec 15	Jul 20 to Dec 31	Jul 20 to Jan 20	Jul 15 to Jan 25	Jul 5 to Dec 15	June 10 to Dec 31	June 10 to Dec 31	June 20 to Jan 10	June 20 to Jan 31	June 5 to Jan 10
Arctic Class 2 7.	No Entry	No Entry	Aug 15 to Sept 30	Aug 1 to Oct 31	No Entry	Aug 15 to Nov 20	Aug 1 to Nov 20	Aug 1 to Nov 30	Aug 1 to Dec 20	Jul 25 to Dec 20	Jul 10 to Nov 20	June 15 to Dec 5	June 25 to Nov 15	June 25 to Dec 10	June 25 to Dec 20	June 10 to Dec 10
Arctic Class 1A 8.	No Entry	No Entry	Aug 20 to Sept 15	Aug 20 to Sept 30	No Entry	Aug 25 to Oct 31	Aug 10 to Nov 5	Aug 10 to Nov 20	Aug 10 to Dec 10	Aug 1 to Dec 10	Jul 15 to Nov 10	Jul 1 to Nov 10	Jul 15 to Oct 31	Jul 1 to Nov 30	Jul 1 to Dec 10	June 20 to Nov 30
Arctic Class 1 9.	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 25 to Sept 30	Aug 10 to Oct 15	Aug 10 to Oct 31	Aug 10 to Oct 31	Aug 1 to Oct 31	Jul 15 to Oct 20	Jul 1 to Oct 31	Jul 15 to Oct 15	Jul 1 to Nov 30	Jul 1 to Nov 30	June 20 to Nov 15
Type A 10.	No Entry	No Entry	Aug 20 to Sept 10	Aug 20 to Sept 20	No Entry	Aug 15 to Oct 15	Aug 1 to Oct 25	Aug 1 to Nov 10	Aug 1 to Nov 20	Jul 25 to Nov 20	Jul 10 to Oct 31	June 15 to Nov 10	June 25 to Oct 22	June 25 to Nov 30	June 25 to Dec 5	June 20 to Nov 20
Type B 11.	No Entry	No Entry	Aug 20 to Sept 5	Aug 20 to Sept 15	No Entry	Aug 25 to Sept 30	Aug 10 to Oct 15	Aug 10 to Oct 31	Aug 10 to Oct 31	Aug 1 to Oct 31	Jul 15 to Oct 20	Jul 1 to Oct 25	Jul 15 to Oct 15	Jul 1 to Nov 30	Jul 1 to Nov 30	June 20 to Nov 10
Type C 12.	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 25 to Sept 25	Aug 10 to Oct 10	Aug 10 to Oct 25	Aug 10 to Oct 25	Aug 1 to Oct 25	Jul 15 to Oct 15	Jul 1 to Oct 25	Jul 15 to Oct 10	Jul 1 to Nov 25	Jul 1 to Nov 25	June 25 to Nov 10
Type D 13.	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 10 to Oct 5	Aug 15 to Oct 20	Aug 15 to Oct 20	Aug 5 to Oct 20	Jul 15 to Oct 10	Jul 1 to Oct 20	Jul 30 to Sept 30	Jul 10 to Nov 10	Jul 5 to Nov 10	Jul 1 to Oct 31
Type E 14.	No Entry	No Entry	No Entry	No Entry	No Entry	No Entry	Aug 10 to Sept 30	Aug 20 to Oct 20	Aug 20 to Oct 15	Aug 10 to Oct 20	Jul 15 to Sept 30	Jul 1 to Oct 20	Aug 15 to Sept 20	Jul 20 to Oct 31	Jul 20 to Nov 5	Jul 1 to Oct 31



Ref: Arctic Shipping Pollution Prevention Regulations: — Authorized Periods of navigation in shipping control zone 13 (Lancaster Sound) by ships carrying 453 cubic metres of oil or more.

Figure 4

network at coastal radio stations in the Canadian Arctic (Figure 2). These radio stations enable radio communications between ships and the shore for business and private communications, for distress alerting, for search and rescue co-ordination, and for medical advice. In addition, regular broadcasts from these stations provide ship masters with weather forecast information, navigation warnings, and ice-cover information.

SUPPLY OPERATIONS

In March 1975 the Treasury Board re-appointed Transport Canada as the exclusive federal co-ordinator for the preparation and conduct of annual supply operations in the Eastern Canadian Arctic. This mandate also gave Transport Canada responsibility for co-ordinating United States Air Force cargos consigned to Defence Early Warning (DEW) Line stations located in the Eastern Canadian Arctic. Departmental guidelines call for the use of Canadian ships whenever possible or, alternatively when circumstances dictate, a Coast Guard ship. Much of the detailed co-ordination is managed by Coast Guard Headquarters in Ottawa. During the arctic summer navigation season, Coast Guard Headquarters

monitors the scheduled movements of supply ships; directs the operations of icebreakers deployed to the Arctic; positions area cargo superintendent's at Frobisher Bay and Resolute; and arranges for the dissemination of ice-cover information in the Arctic, prepared by Environment Canada's "Ice Central" in Ottawa. The primary objective of this infrastructure is the timely and safe delivery of cargo consigned to various arctic communities, including those located in the vicinity of Lancaster Sound. Cargo deliveries, including oil products, for communities located in the vicinity of Lancaster Sound totalled 6 850 t in 1979.

ARCTIC MARINE EMERGENCY PLAN

Ship-generated pollution is a worldwide issue and has been the main catalyst in the production of international and national regulations designed to correct the incidence and the effects of this type of pollution. These regulations usually focus on the safety of ship construction, the competence of ship operators, and the control of ships during the navigation passage, particularly in coastal waters. The Arctic Marine Emergency Plan sets out the Coast Guard's response mechanism for marine incidents which involve

pollutants from ships. Coast Guard Headquarters in Ottawa has operational responsibility for containing and cleaning up pollution in accordance with the provisions of the National Marine Emergency Plan. Federal policy is to allocate what is called "lead agency" responsibility for different types of emergency to particular departments. The Coast Guard, through legislation, regulation, inter-agency agreement, custom and precedent, has a lead-agency responsibility in the Canadian Arctic for all emergencies resulting from ships, including their equipment, cargo, fuel, and stores. When an emergency occurs in the lead agency's mandate, the agency is responsible for organizing, commanding, and guiding the response.

NOMINAL SHIPPING FORECASTS (LANCASTER SOUND)

The annual volumes of ship traffic through Lancaster Sound for any given year during the next 20 years will depend on a number of independent but subjective variables. The more important variables include the government's arctic shipping policy, demands for arctic resources, the duration of the annual navigation season, growth of arctic coastal communities, shipping used for supply and research, and

government support of arctic shipping.

The government's arctic shipping policy is an important factor. For example, a policy that limits the transportation of goods between the Arctic and southern Canadian ports to ships built and registered in Canada might result in a slower increase of shipping volume than a policy that favours multi-national participation in this special trade.

The domestic and foreign demands for arctic minerals, gas, and oil resources accessible to ships routed through the Northwest Passage via Lancaster Sound are directly influenced by a number of cost factors, including the costs of transporting the respective resources to their domestic or foreign markets. Resources demand will be a major regulator of shipping volume.

The duration of the annual navigation season depends on the inventory of arctic class 7 ships and above. Theoretically, longer navigation seasons should result in increased shipping volumes. However, the trend of traffic increases may be irregular and may have a tendency to peak during the favourable months of July to October.

Demographic growth of arctic coastal communities along the Northwest Passage could mean increased volume of annual arctic supply operations during the next 20 years, provided

larger ships are not used to compensate for the increased volume of cargo.

The extent and annual duration of marine services provided by the government in support of arctic shipping will also be a factor in the possible increase in shipping activity. These include the operation of coastal radio stations; the NORDREG CANADA Traffic Centre; the provision of navigational warnings, weather, and ice-cover information; the positioning and operation of a suitable and effective search and rescue infrastructure; the positioning and operation of the marine emergency infrastructure; steamship inspection services; customs and excise offices. The absence of safety-oriented services could counter perceived economic benefits of an extended navigation season.

CONCLUSION

This paper has provided a brief overview of the role of shipping in the economy of the Arctic and its possible effects on the environment. The role of shipping is subordinate to the roles of financial and commercial organizations which

provide the resources for large-scale Arctic developments. Shipping also plays an indispensable role in annual Arctic re-supply operations. If there are increased volumes of shipping routed through Lancaster Sound, attributable to extended navigation seasons over the next 20 years, then it will be necessary to develop and implement appropriate marine pollution countermeasures regimes capable of countering ship-generated pollution incidents which might occur.

Canada